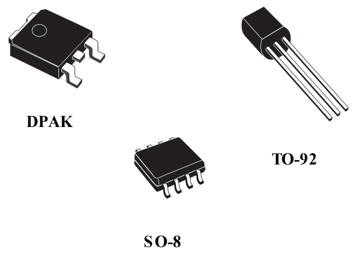
LM2931

Datasheet

Very low drop voltage regulators with inhibit function



Maturity status link
LM2931

Features

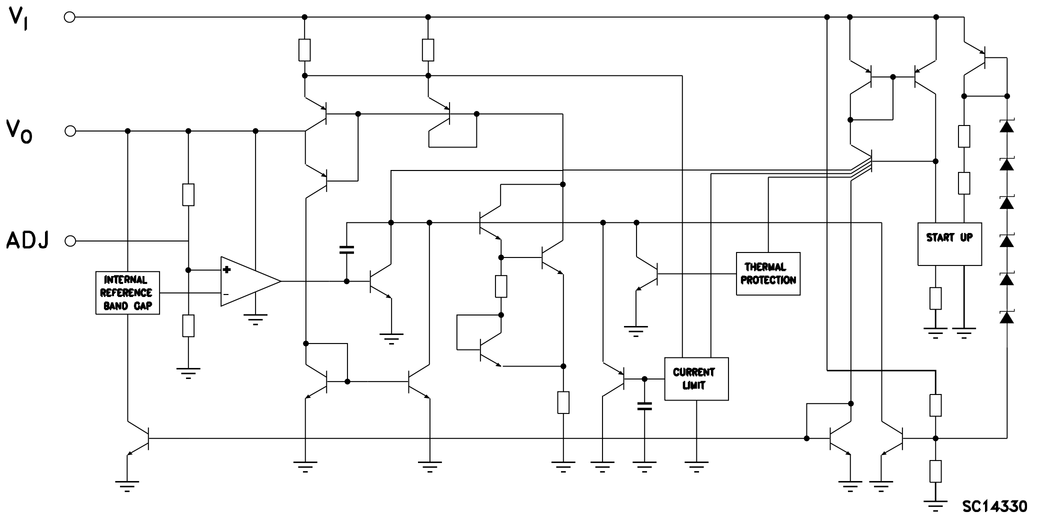
- AEC-Q100 qualified (DPAK only)
- Very low dropout voltage (90 mV typ. at 10 mA load)
- Low quiescent current (typ. 2.5 mA, at 100 mA load)
- Output current up to 100 mA
- Adjustable (from V_{OUT} = 2.5 V only SO-8) and fixed (3.3 V and 5 V) output voltage version
- Internal current and thermal limit
- Load dump protection up to 60 V
- Reverse transient protection up to - 50 V
- Temperature range: - 40 to 125 °C
- Package available: TO-92, DPAK, SO-8 (with inhibit control)

Description

The LM2931 are very low drop regulators. The very low drop voltage and the low quiescent current make them particular suitable for low noise, low power applications and in battery-powered systems. In the 8-pin configuration (SO-8), fully compatible with the older L78L family, a shutdown logic control function is available. This means that when the device is used as a local regulator it is possible to put a part of the board in standby, decreasing total power consumption. Ideal for automotive applications, LM2931 is protected from reverse battery installations or 2 battery jumps. During the transient, such as a 60 V load dump, when the input voltage can exceed the specified maximum operating input voltage of 26 V, the regulator automatically shuts down to protect both internal circuitry and the load.

1 Diagram

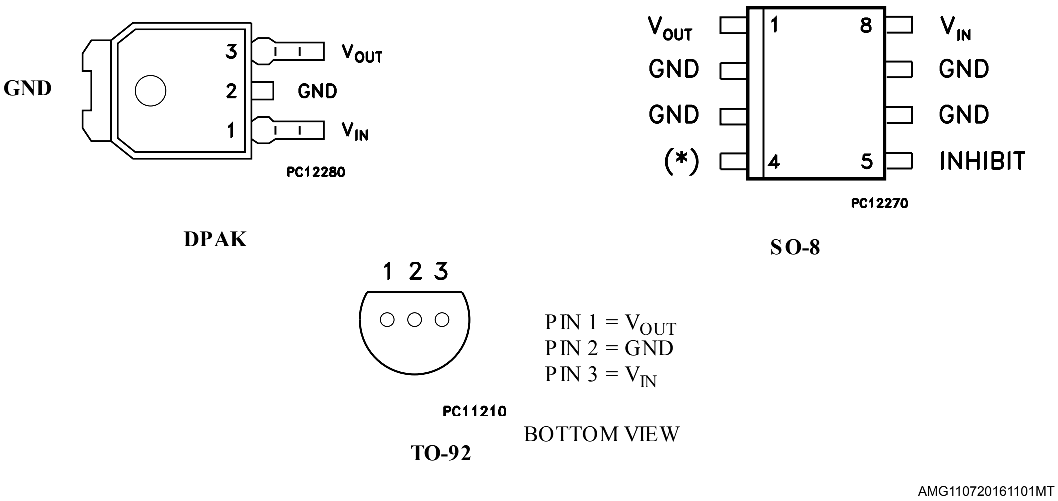
Figure 2. Schematic diagram



AMG110720161100MT

2 Pin configuration

Figure 3. Pin connections (top view)



Note: (*) ADJ pin on the adjustable version, not connected in the fixed output version.

3 Maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_I	DC positive input voltage	40	V
V_I	DC reverse input voltage	-15	V
V_I	Transient input voltage (T < 100 ms)	60	V
V_I	Transient reverse input voltage (T < 100 ms)	-50	V
V_{INH}	Inhibit input voltage	40	V
I_O	Output current	Internally limited	
T_{STG}	Storage temperature range	-65 to 150	°C
T_{OP}	Operating junction temperature range	-40 to 125	°C

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Table 2. Thermal data

Symbol	Parameter	SO-8	DPAK	TO-92	Unit
R_{thJC}	Thermal resistance junction-case	20	8	57	°C/W
R_{thJA}	Thermal resistance junction-ambient	55 (1)	100	200	°C/W

1. *Considering 6 cm^2 of copper board heat-sink.*

4 Application circuits

Figure 4. Application circuit for fixed output

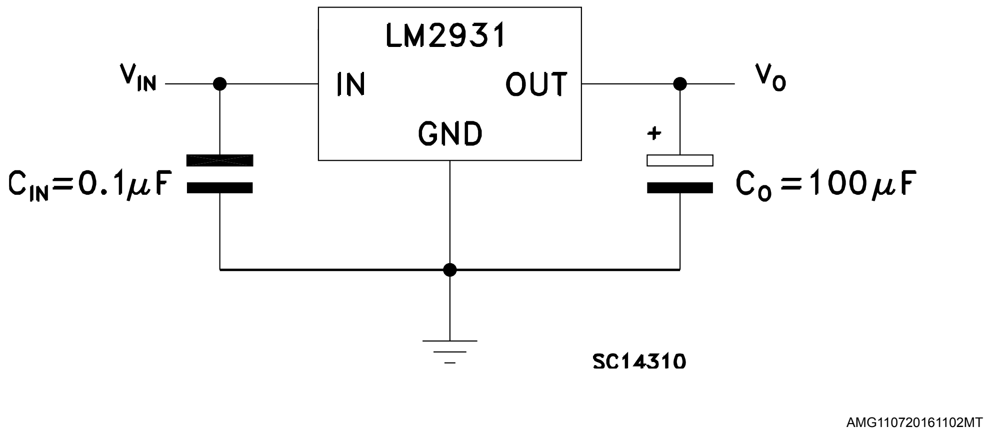
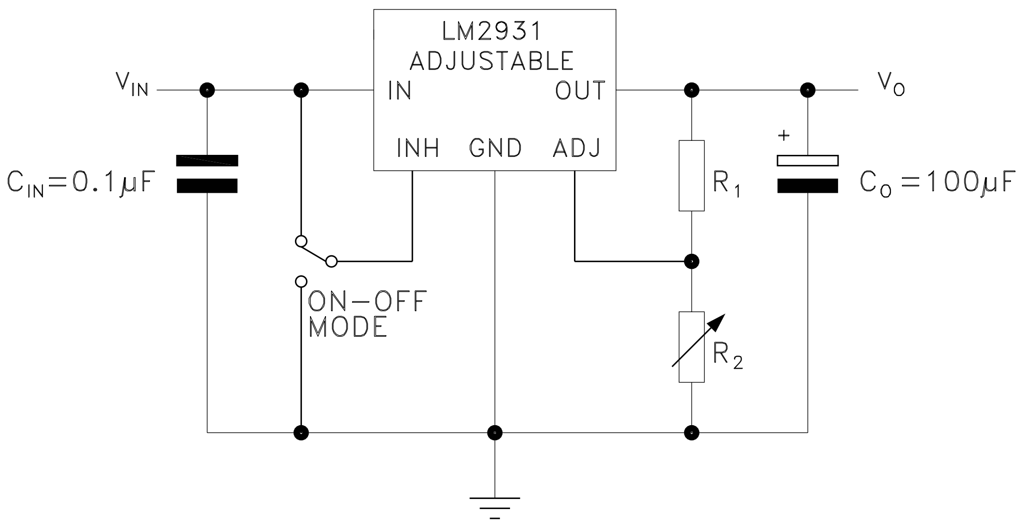


Figure 5. Application circuit for adjustable output



Note: *R_1 suggested value = 27 kΩ*
$V_O = V_{REF} (R_1 + R_2)/R_1$
Inhibit pin: regulator is enabled when V_{INH} < 1.2 V , disabled when V_{INH} > 3.25 V

5 Electrical characteristics

Refer to the application circuit Figure 4. Application circuit for fixed output, T_J = 25 °C, C_I = 0.1 µF, C_O = 100 µF, V_I = 14 V, I_O = 10 mA, V_{INH} = 0 V, unless otherwise specified.

Table 3. Electrical characteristics of LM2931A33/LM2931A33Y

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_I	Maximum operating input voltage	I_O = 10 mA, T_J = -40 to 125 °C	26			V
V_O	Output voltage		3.175	3.3	3.425	V
V_O	Output voltage	I_O = 100 mA, V_I = 6 to 26 V T_J = -40 to 125°C	3.135	3.3	3.465	V
DV_O	Line regulation	V_I = 9 to 16 V		2	10	mV
		V_I = 6 to 26 V		4	33	
DV_O	Load regulation	I_O = 5 to 100 mA		10	33	mV
V_d	Dropout voltage(1)	I_O = 10 mA		90	250	mV
		I_O = 100 mA		250	600	
I_d	Quiescent current ON MODE	I_O = 100 mA		2.5	30	mA
	OFF MODE	V_{INH} = 2.5 V, R_{LOAD} = 330 Ω		0.3	1	mA
I_{SC}	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I_O = 100 mA, V_I = 14 ± 2 V f = 120 Hz	55	78		dB
V_{IL}	Control input voltage low	T_J = -40 to 125 °C		2	1.2	V
V_{IH}	Control input voltage high	T_J = -40 to 125 °C	3.25	2		V
I_{INH}	Inhibit input current	V_{INH} = 2.5 V		22	50	µA
V_I	Transient input voltage	R_{LOAD} = 330 Ω, T < 100 ms	60	70		V
V_I	Reverse polarity input voltage	V_O = ± 0.3 V, R_{LOAD} = 330 Ω	-15	-50		V
V_I	Reverse polarity input voltage transient	R_{LOAD} = 330 Ω, T < 100 ms	-50			V
eN	Output noise voltage	B = 10 Hz to 100 kHz		330		$µV_{RMS}$

1. *V_d measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.*

Refer to the application circuit Figure 4. Application circuit for fixed output, T_J = 25 °C, C_I = 0.1 µF, C_O = 100 µF, V_I = 14 V, I_O = 10 mA, V_{INH} = 0 V, unless otherwise specified.

Table 4. Electrical characteristics of LM2931A50/ LM2931A50Y

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_I	Maximum operating input voltage	I_O = 10 mA, T_J = -40 to 125 °C	26			V
V_O	Output voltage		4.81	5	5.19	V
V_O	Output voltage	I_O = 100 mA, V_I = 6 to 26 V T_J = -40 to 125 °C	4.75	5	5.25	V
DV_O	Line regulation	V_I = 9 to 16 V		2	10	mV
		V_I = 6 to 26 V		4	30	
DV_O	Load regulation	I_O = 5 to 100 mA		15	50	mV
V_d	Dropout voltage(1)	I_O = 10 mA		90	200	mV
		I_O = 100 mA		250	600	

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_d	Quiescent current ON MODE	I_O = 100 mA		2.5	30	mA
	OFF MODE	V_{INH} = 2.5 V, R_{LOAD} = 500 Ω		0.3	1	mA
I_{SC}	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I_O = 100 mA, V_I = 14 ± 2 V f = 120 Hz	55	75		dB
V_{IL}	Control input voltage low	T_J = -40 to 125 °C		2	1.2	V
V_{IH}	Control input voltage high	T_J = -40 to 125 °C	3.25	2		V
I_{INH}	Inhibit input current	V_{INH} = 2.5 V		22	50	µA
V_I	Transient input voltage	R_{LOAD} = 500 Ω, T < 100 ms	60	70		V
V_I	Reverse polarity input voltage	V_O = ± 0.3 V, R_{LOAD} = 500 Ω	-15	-50		V
V_I	Reverse polarity input voltage transient	R_{LOAD} = 500 Ω, T < 100 ms	-50			V
eN	Output noise voltage	B = 10 Hz to 100 kHz		500		μV_{RMS}

1. *V_d measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.*

Refer to the application circuit Figure 5. Application circuit for adjustable output with R_1 = 27 KΩand R_2 = 40.5 kΩ, T_J = 25 °C, C_I = 0.1 µF, C_O = 100 µF, V_I = 14 V, I_O = 10 mA, V_{INH} = 0 V, unless otherwise specified.

Table 5. Electrical characteristics of LM2931 (adjustable version)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_I	Maximum operating input voltage	I_O = 10 mA, T_J = -40 to 125 °C	26			V
V_{REF}	Reference voltage (1)		1.14	1.2	1.26	V
V_{REF}	Reference voltage (1)	I_O = 100 mA, T_J = -40 to 125 °C	1.08	1.2	1.32	V
DV_O	Line regulation	V_I = 3.6 to 26 V		0.6	4.5	mV
DV_O	Load regulation	I_O = 5 to 100 mA		9	30	mV
V_d	Dropout voltage(2)	I_O = 10 mA		90	200	mV
		I_O = 100 mA		250	600	
I_d	Quiescent current ON MODE	I_O = 100 mA		2.5	30	mA
	OFF MODE	V_{INH} = 2.5 V, R_{LOAD} = 300 Ω		0.3	1	mA
I_{SC}	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I_O = 100 mA, V_I = 14 ± 2 V f = 120 Hz	55	80		dB
V_{IL}	Control input voltage low	T_J = -40 to 125 °C		2	1.2	V
V_{IH}	Control input voltage high	T_J = -40 to 125 °C	3.25	2		V
I_{INH}	Inhibit input current	V_{INH} = 2.5 V		22	50	µA
V_I	Transient input voltage	R_{LOAD} = 300 Ω, T < 100 ms	60	70		V
V_I	Reverse polarity input voltage	V_O = ± 0.3 V, R_{LOAD} = 300 Ω	-15	-50		V
V_I	Reverse polarity input voltage transient	R_{LOAD} = 300 Ω, T < 100 ms	-50			V
eN	Output noise voltage	B = 10 Hz to 100 kHz		330		μV_{RMS}

1. *Reference voltage is measured from V_{OUT} to ADJ pin.*
2. *V_d measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.*

6 Typical characteristics

Unless otherwise specified C_I = 0.1 µF, C_O = 100 µF.

Figure 6. **Output voltage vs temperature**

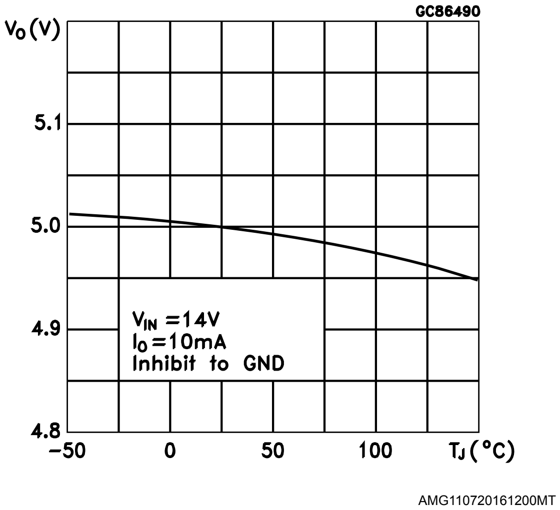


Figure 7. **Output voltage vs temperature**

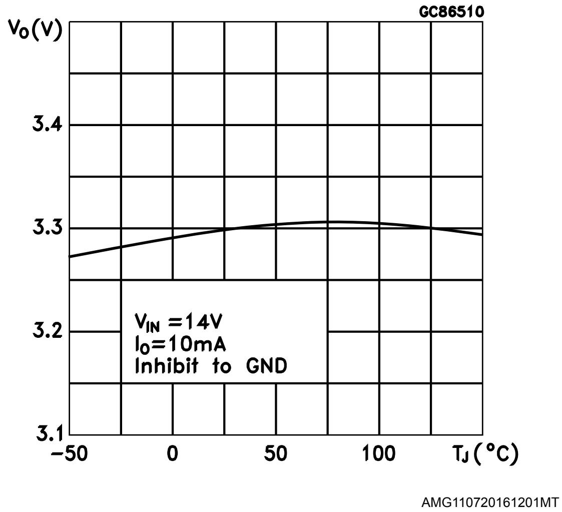


Figure 8. **Reference voltage vs temperature**

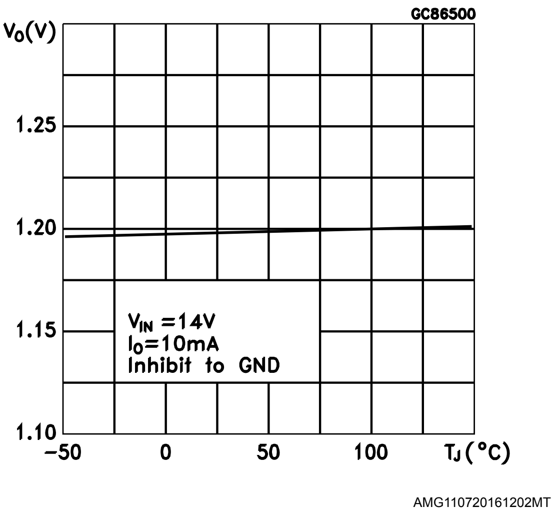


Figure 9. **Line regulation vs temperature**

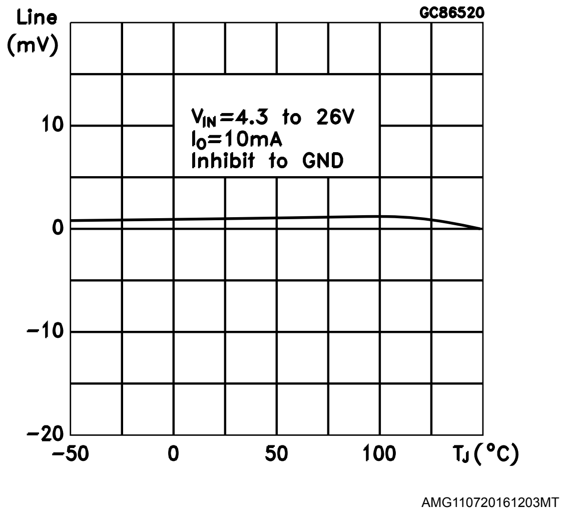


Figure 10. Load regulation vs temperature

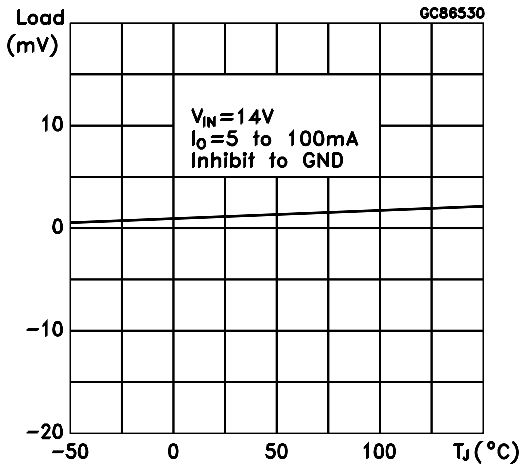


Figure 11. Dropout voltage vs temperature

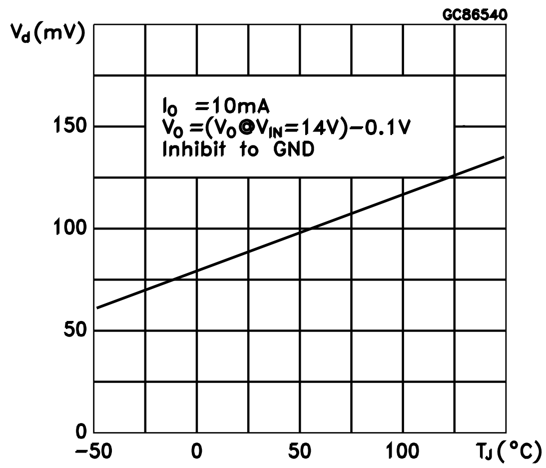


Figure 12. Dropout voltage vs temperature

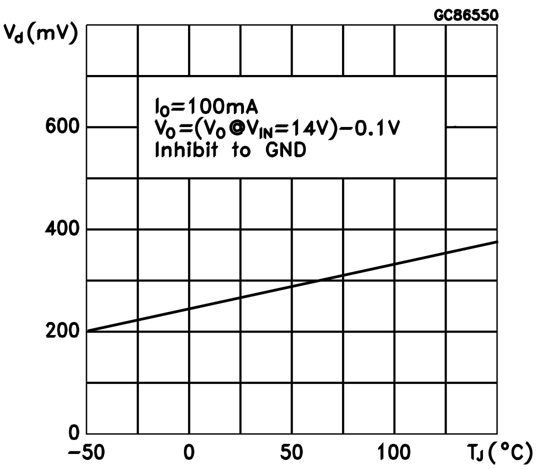


Figure 13. Dropout voltage vs output current

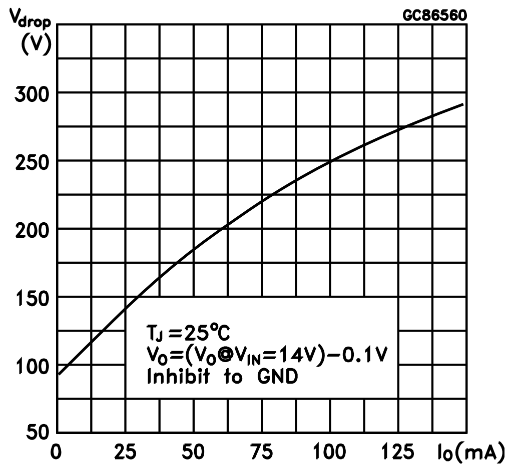


Figure 14. Output voltage vs input voltage

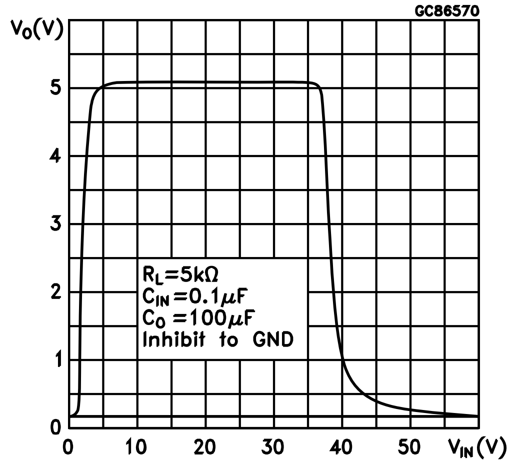


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Figure 15. Short circuit current vs drop voltage

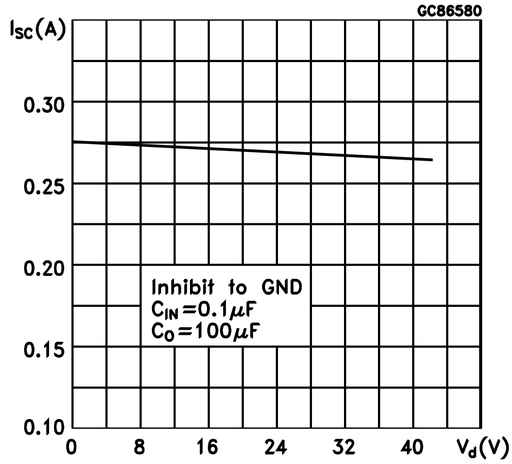

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Figure 16. Quiescent current vs temperature

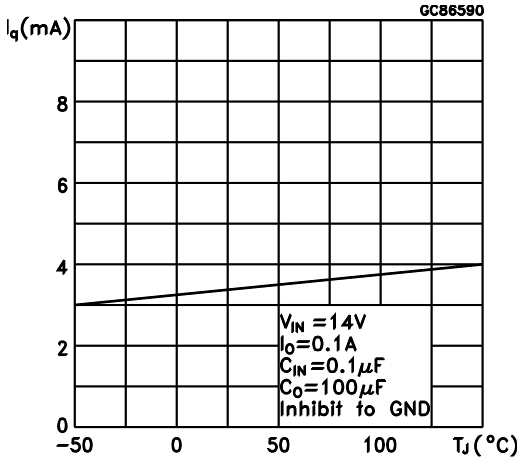

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Figure 17. Quiescent current vs input voltage

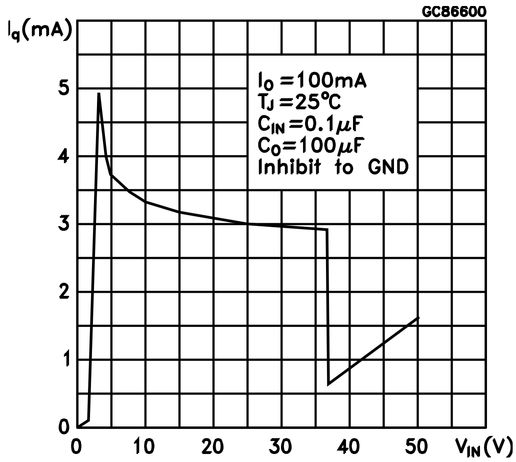

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Figure 18. Quiescent current vs output current

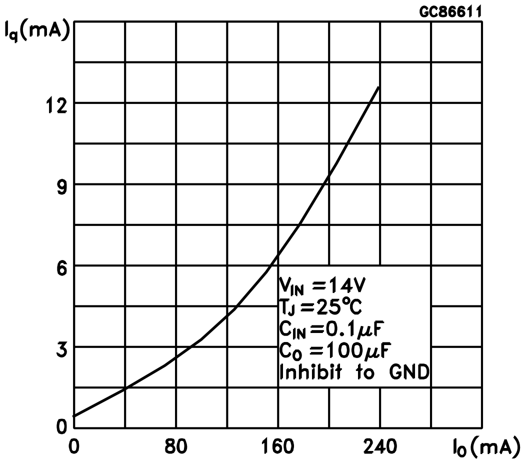

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Figure 19. Supply voltage rejection vs temperature

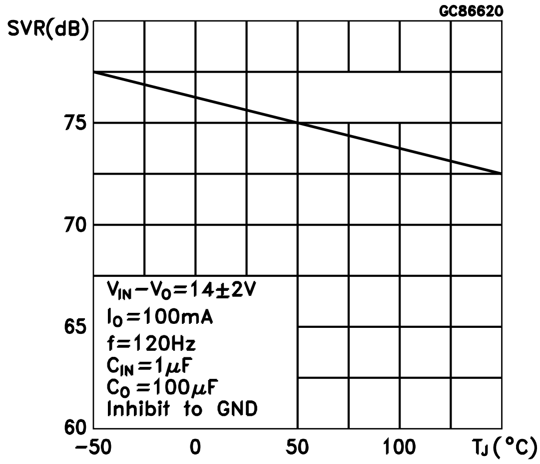

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Figure 20. Supply voltage rejection vs frequency

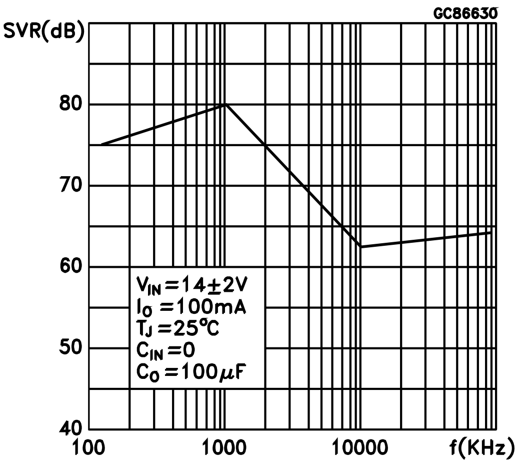

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Figure 21. Supply voltage rejection vs output current

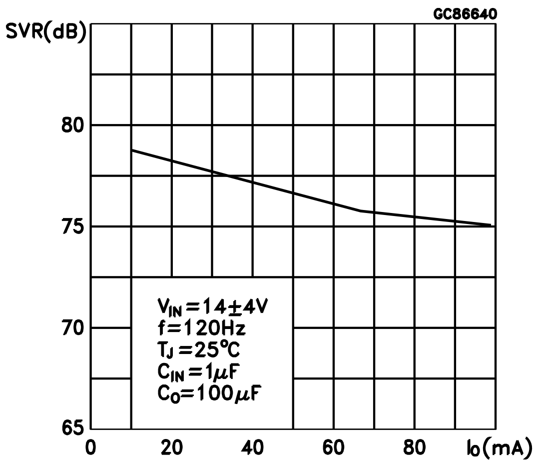

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Figure 22. Stability vs C_O

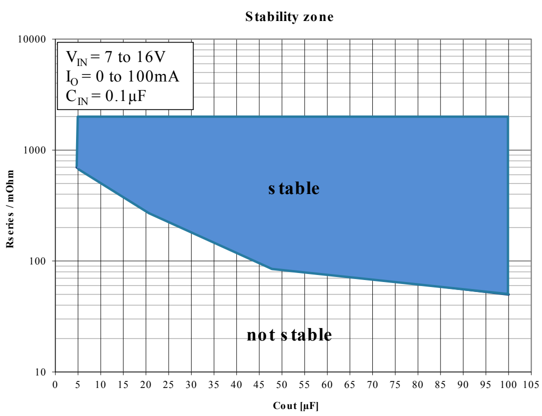

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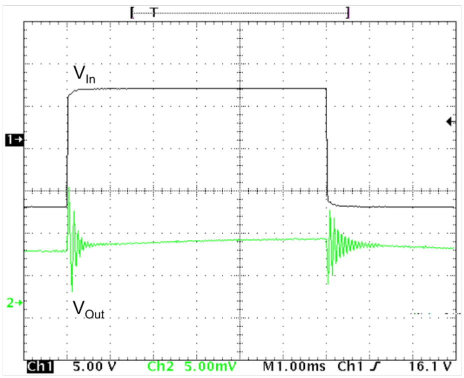
Figure 23. Line transient



V_{IN}= 6 to 20 V, R_L=500 Ohm, T= 25°C, C_{in}=0, C_{out}=100 µF, Rise Fall-Time = 200ns

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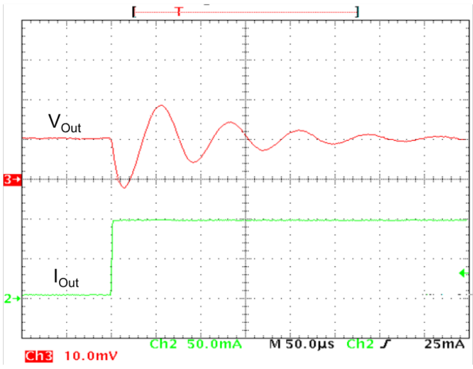
Figure 24. **Load transient**



I_O = 5 to 100 mA, V_{IN}=14V, T= 25°C, C_{in}=0.1 µF, C_{out}=100 µF
Rise Time = 500ns, Fall Time =1µs

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7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

7.1 DPAK package information

Figure 25. **DPAK package outline**

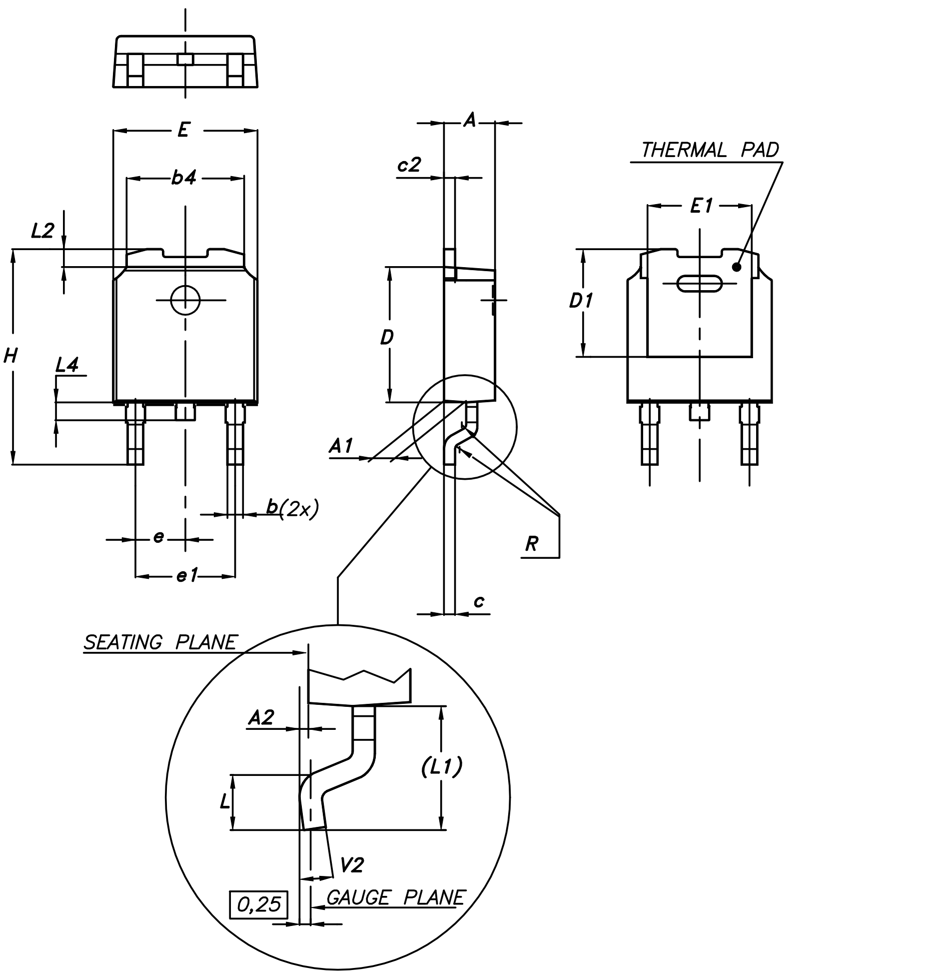
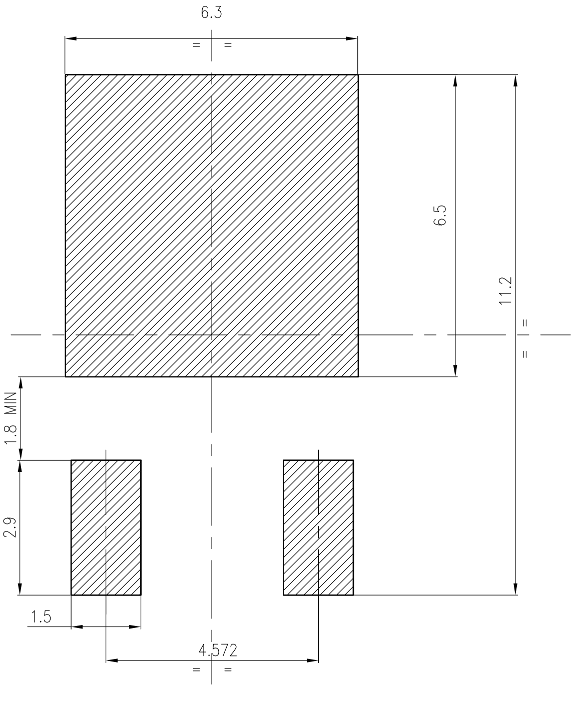


Table 6. **DPAK mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20

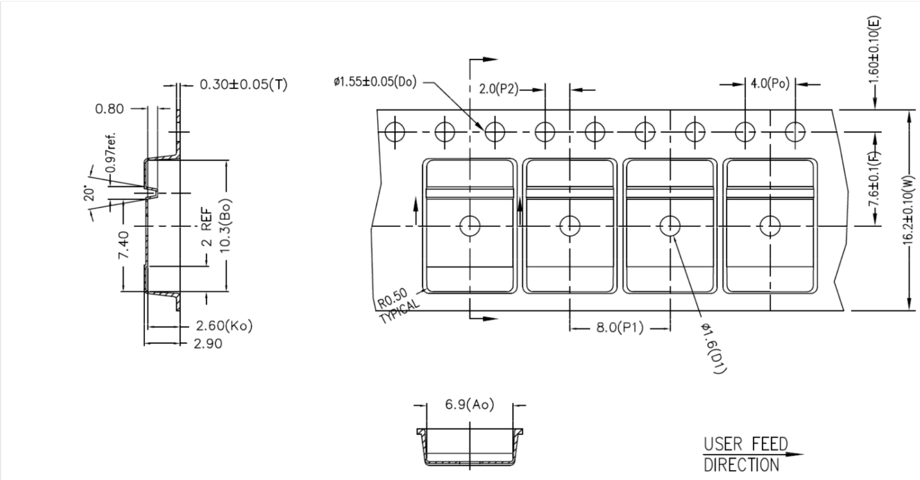
Dim.	mm		
	Min.	Typ.	Max.
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)		2.80	
L2		0.80	
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 26. **DPAK recommended footprint (dimensions are in mm)**



7.2 DPAK packing information

Figure 27. DPAK tape outline



NOTES:

1. MATERIAL: CONDUCTIVE POLYSTYRENE
2. Po/P1 20 PITCHES CUMULATIVE TOLERANCE ON TAPE: ±0.20
3. Ao & Bo MEASUREMENT POINT TO BE 0.3 FROM BOTTOM POCKET .
4. ALLOWABLE CAMBER TO BE 1/100mm, NON–CUMULATIVE OVER 250mm
5. SURFACE RESISTIVITY 10E5 TO 10E11 OHMS/SQ

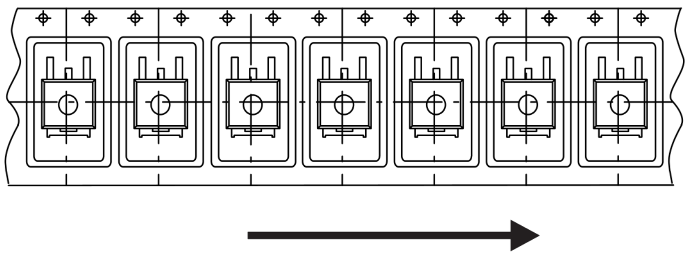
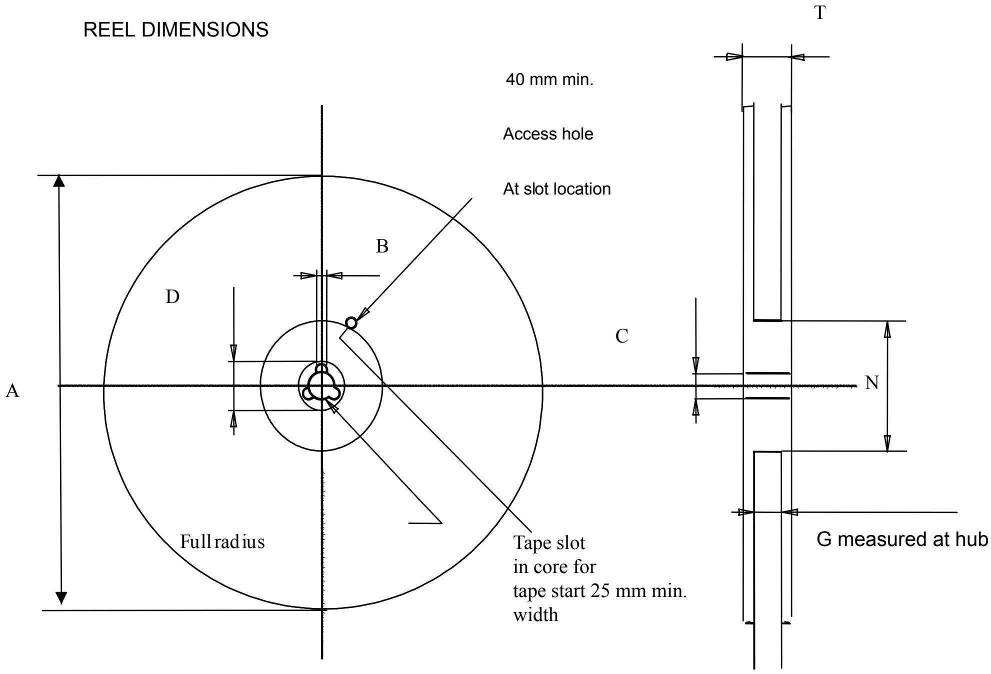


Figure 28. DPAK reel outline



7.3 SO8 package information

Figure 29. SO-8 package outline

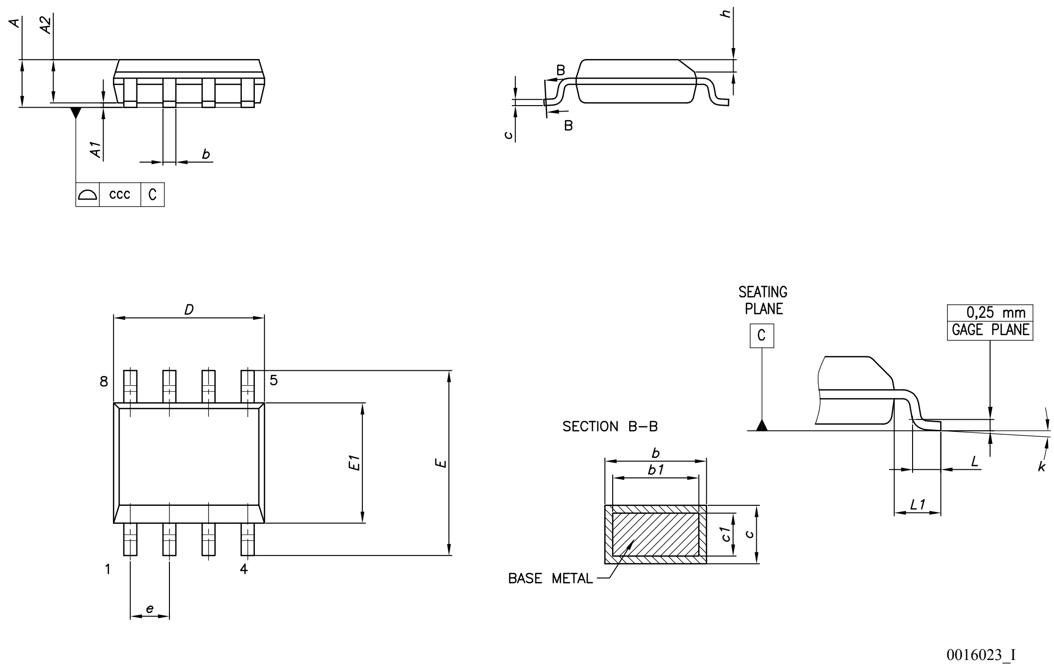
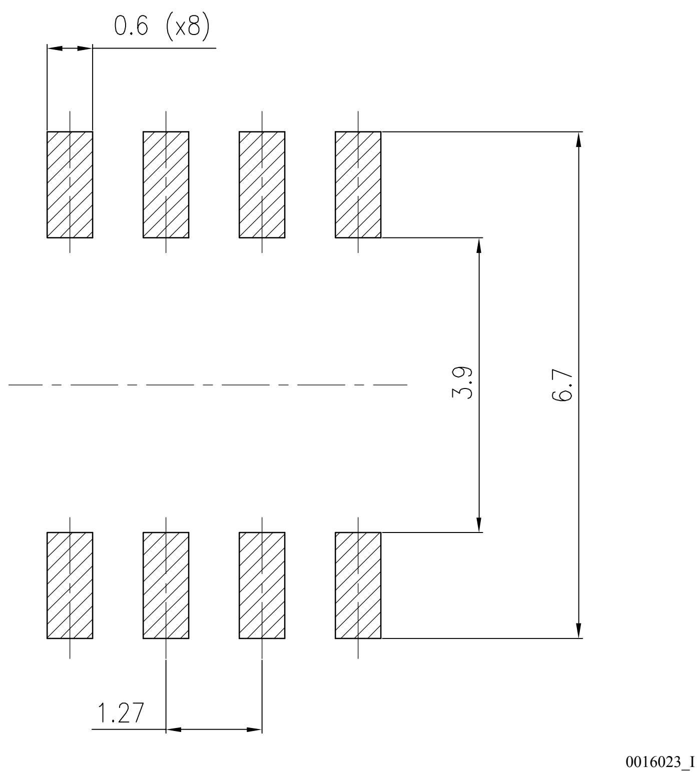


Table 7. **SO-8 mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A			1.75
A1	0.10		0.25
A2	1.25		
b	0.28		0.48
c	0.17		0.23
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e		1.27	
h	0.25		0.50
L	0.40		1.27
L1		1.04	
k	0°		8°
ccc			0.10

Figure 30. **SO-8 recommended footprint**



7.4 SO-8 packing information

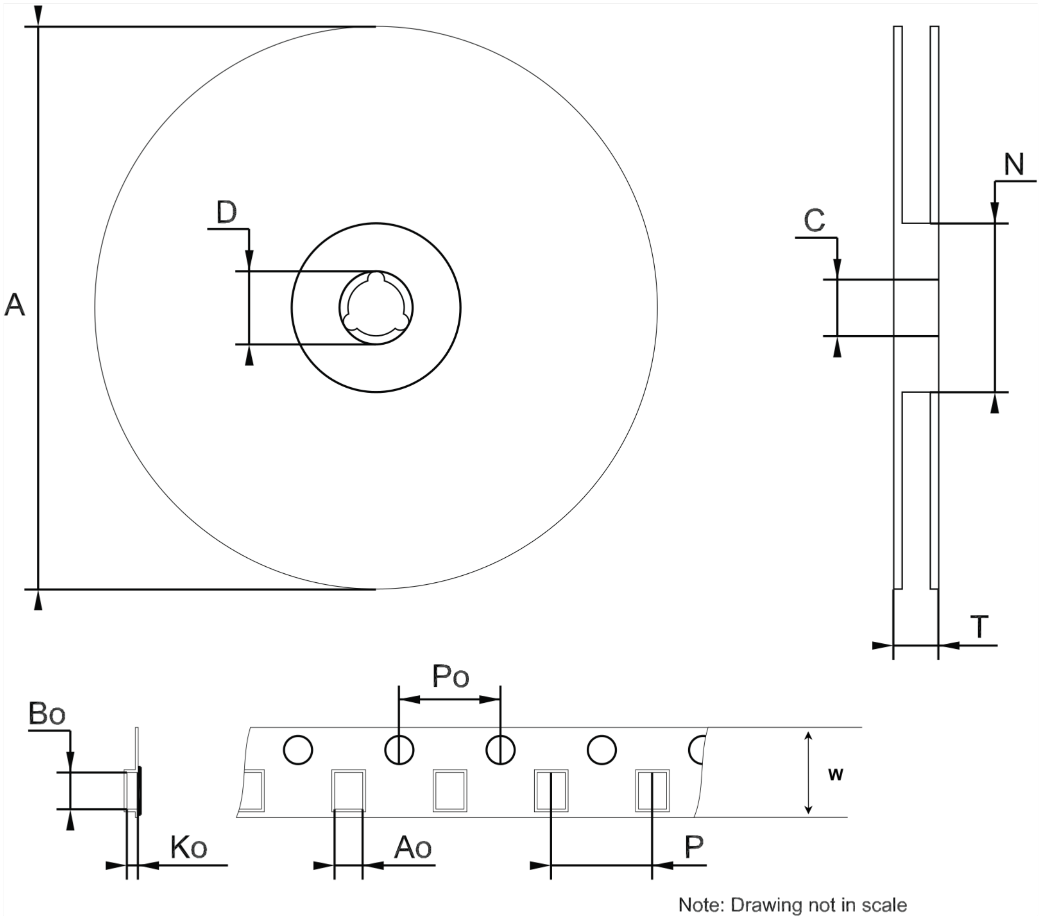


Figure 31. **SO-8 tape and reel outline**

Table 8. **SO-8 mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A			330
C	12.8		13.2
D	20.2		
N	50		
T			22.4
Ao	6.4	6.5	6.6
Bo	5.2		5.4
Ko	2.1		2.3
Po	3.9		4.1
P	7.9		8.1
W	11.7	12.0	12.3

7.5 TO-92 package information

Figure 32. TO-92 package outline

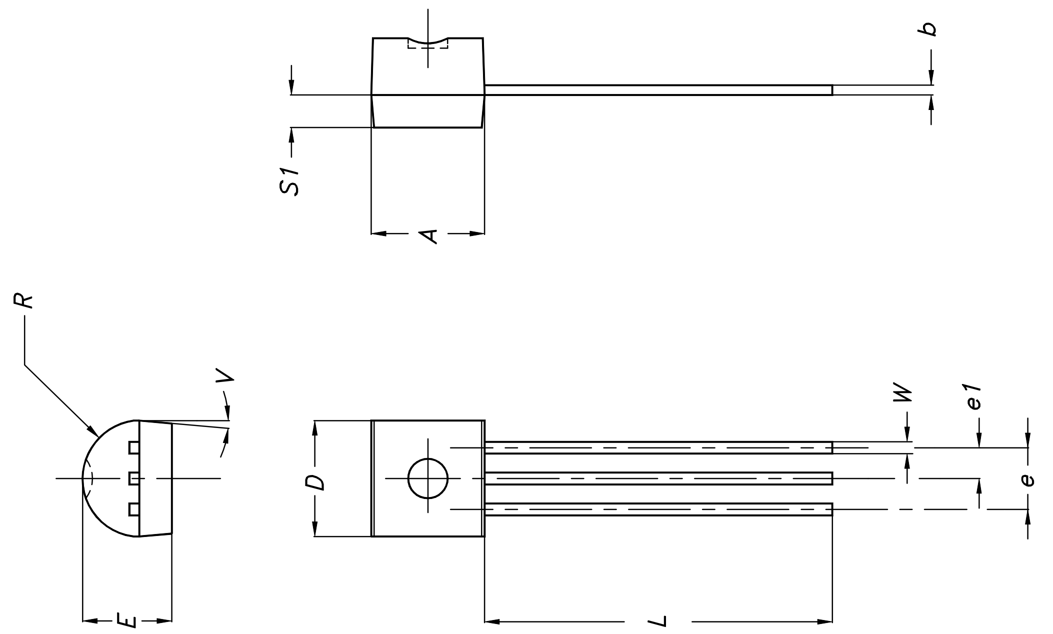


Table 9. TO-92 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.32		4.95
b	0.36		0.51
D	4.45		4.95
E	3.30		3.94
e	2.41		2.67
e1	1.14		1.40
L	12.70		15.49
R	2.16		2.41
S1	0.92		1.52
W	0.41		0.56
V		5°	

8 Ordering informations

Table 10. **Order code**

DPAK		TO-92 (bag)	SO-8	Output voltages
AG	Standard			
LM2931ADT33RY (1)			LM2931AD33R	3.3 V
LM2931ADT50RY(1)	LM2931ADT50R	LM2931AZ50R	LM2931AD50R	5.0 V
			LM2931D-R	2.5 to 26 V

1. *Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent .*

Revision history

Table 11. Document revision history

Date	Revision	Changes
21-Jun-2004	12	Document updated.
16-Jun-2006	13	Order codes updated.
27-Jul-2007	14	Added Table 1 in cover page.
21-Aug-2007	15	Added root part number - (see Table 1).
22-Nov-2007	16	Modified: Table 1.
11-Feb-2008	17	Modified: Table 1 on page 1.
10-Jul-2008	18	Removed package TO-220, modified Table 1 on page 1.
26-May-2010	19	Modified: V_I values Table 4 on page 6, Table 5 on page 7 and Table 6 on page 8.
02-Nov-2011	20	Modified: Figure 4 on page 6. Added: (*) ADJ pin on the Adjustable version, Not Connected in the fixed output version. on page 4 and Inhibit pin: regulator is enabled when VINH < 1.2 V , disabled when VINH > 3.25 V on page 6.
09-Apr-2014	21	Part numbers LM2931XX, LM2931AXX33 and LM2931AXX50 changed to LM2931. Updated the description in cover page Section 2: Pin configuration and Section 7: Package information. Added Section 8: Revision history. Minor text changes.
16-Mar-2017	22	Updated features in cover page, removed Table 1. Device summary from cover page, Table 3: "Electrical characteristics of LM2931A33/LM2931A33Y" , Table 4: "Electrical characteristics of LM2931A50/ LM2931A50Y" and Table 5: "Electrical characteristics of LM2931 (adjustable version)". Updated Section 7: "Package information". Added Section 8: "Ordering information". Minor text changes.
23-Feb-2018	23	Updated Figure 5. Application circuit for adjustable output.

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